Responses to Questions/Concerns Raised by Oregon Forest Industries Council Regarding the Protecting Cold Water Criterion of Oregon's Temperature Water Quality Standard

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Reasons for a Protecting Cold Water Criterion:

- Natural thermal regime provides best conditions for fish & other native aquatic organisms;*
- Value in diversity of temperatures, including colder than BBNC;*
- Prevent accumulation of heat in fish-bearing reaches;*
- Retain assimilative capacity for climate variation & climate change.

*From Summary of 2003 Technical Advisory Committee findings

Responses to Forest Industry Questions/Concerns:

1. Paired watershed studies do add to the body of science on fish populations & stream temperature, but not in a way that shows a lack of need for the Protecting Cold Water Criterion.
    a. Hinkle & Alsea studies show increases in fish-bearing streams within the range of responses from RipStream.
    b. WRC studies' inference is short-term, reach-level effects, primarily on resident cutthroat.
    c. The purpose of the standard is maintenance and restoration of natural thermal regimes across the landscape for all aquatic species.
    d. Prevention of short-term, reach level effects to fisheries are a goal to the standard, but are not the primary purpose.
    e. Meeting the standard preserves the capacity of waterbodies to assimilate natural fluctuations in temperature due to year-to-year climate variations & to better maintain cold-water communities in a warming climate.

2. Thermal diversity across the landscape is necessary. Small increases in stream temperature can have negative effects on fish populations, particularly when occurring across the landscape.
    a. Temperature 303(d) listings & TMDLs exist across Oregon.
    b. Temperature effects typically occur on a continuum; increases from natural thermal potential increase risk to fish (US EPA 2001).

c. Heating of headwaters reduces the extent of downstream waters at optimal growth & physiological temperatures & increases the extent at high-risk & lethal temperatures for rearing & migration.
d. Multiple stressors in the environment must be considered. By preventing or reducing temperature stress, we reduce the risks due to multiple stressors on fish populations (e.g. OCCCP bottlenecks).
e. When there is uncertainty, DEQ must make conservative choices to ensure protection of the resource.

3. Thermal loads do move downstream, heat loss mechanisms are much less efficient than heat gain by solar radiation, & dilution of thermal loads is not the same as dissipation, especially with multiple harvests.
    a. In open canopy streams, input of solar radiation typically composes about 50% – 90% of the total heat energy flux (Figures 1 & 2; see Johnson 2004, Benyahya *et al* 2012).
    b. A single source's temperature effects become hard to track downstream, but DEQ calculates thermal loads for TMDLs & permits.
    c. DEQ HeatSource modeling indicates long distances (1000 meters +) are required to lose thermal energy via evaporation & longwave radiation (when tributary & groundwater inputs are held constant).
        i. HeatSource modeling on 2 RipStream sites (5556 & 7854) shows persistent temperature increases a kilometer or more from the end of harvest units (Figures 3 & 4); and
        ii. Harvest of additional downstream unit on 5556 creates greater increase at confluence with Drift Creek (Figure 5).
    d. Davis *et al* (in review):
        i. Average increase on private lands *as harvested* was 0.7°C. Average case for Davis *et al* travel distance for 0.7°C →0.3°C ≈300m. Minimum case is ≈120m, maximum case ≈1125m.
            1. Only 6 of 18 private sites were harvested to or near FPA minimum retention targets.
        ii. Average increase on private land *as modeled to FPA minima* is 1.7°C (draft result). Average case for Davis *et al* travel distance for 1.7°C →0.3°C ≈650m. Minimum case is ≈140m, maximum case ≈2700m.
    e. Cole & Newton (2013) showed that with uncut units interspersed with harvest units, stream reaches showed overall increases in temperature trends post-harvest for 3 of 4 study reaches.

4. The current disturbance regime is very different than the pre-settlement disturbance regime in both frequency & type of disturbance.
    a. Thermal recovery post-disturbance is 7-15 years, with 10 years as a reasonable mid-range value (Johnson & Jones 2000; D'Souza *et al* 2011; Rex *et al* 2012; RipStream data, *unpublished*).

b. With a 40-year rotation (assuming steady yearly harvest rate), 25% of the private industrial forestland base would be in thermal recovery.
c. Based on change in Landsat land cover from 1985-2009 (Figure 6), the average percentage of private forestland (65.1% of total land area) in the MidCoast basin in the 10-yr thermal recovery period is 17% for the time period 1994-2009.
    i. The total for all land uses combined is 10%.
    ii. Varies over time & space.
        1. In 2008, 39.9% of private forestland in the Middle Siletz River watershed was in thermal recovery.
        2. In 1996, 5.3% of private forestland in the Drift Creek watershed was in thermal recovery. [Maximum of 34.9% in 2008]
d. Agee (1990) estimates that historically (prior to Euro-American settlement) an average 0.24% and 0.67% of cedar/spruce/hemlock and western hemlock/Douglas-fir forests, respectively, burned annually.
    i. Gives an average area in thermal recovery estimate of 2.4% for cedar/spruce/hemlock & 6.7% for western hemlock/Douglas-fir.
e. Wimberly (2002) estimates that a median of 17% of Oregon's coastal province would be in early successional condition (<30 years since fire of varying severity).
    i. Using 10 years as above, Wimberly's estimate gives 5.7% of forestlands historically in thermal recovery.
f. High-severity fires leave more wood & live vegetation than clearcut harvest, and there are differences between unmanaged terrestrial & riparian early succession compared to clearcut harvest & replanting methods (Reeves *et al* 1995, Swanson *et al* 2011).
g. Fire return intervals in western Oregon range from 100-400 years. Shorter intervals typically are associated with less severity (Morrison & Swanson 1990).
h. Fire return for high severity fires is typically 200 years (Wimberly 2002), compared to harvest rotation of 40 years.

5. If taking a non-conservative approach to the effects of a single harvest, then we must address actual landscape conditions & the effects of multiple harvests.

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